THE AIR FORCE IN SPACE

FISCAL YEAR 1968

Part I

by

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FOREWORD

This is the eleventh in a series of historical reports on USAF space activities published by the Office of Air Force History. As explained in an earlier narrative, the Air Force's most complex and most expensive space endeavor in recent years, the Manned Orbiting Laboratory (MOL), is not covered in these reports. For reasons of security, the MOL project has been given separate historical treatment. Similarly, the present report is being published in two parts, with distribution of Part II limited because of the special access security aspects of the subject matter.

The Air Force in Space, Fiscal Year 1968, is based on primary sources in the files of the Directorate of Space (Projects Development Division, and Policy and Plans Group); the Directorate of Plans Library; and the Directorate of Command, Control, and Communications. In addition, the author has reviewed pertinent files and correspondence in the Office of the Secretary of the Air Force. Among the topics discussed are the Air Force mission in space, satellite communications, space experiments, advanced space technology, booster development, navigation satellites, and other related subjects.

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Part I

I. THE AIR FORCE MISSION IN SPACE

[redacted] The rationale behind Air Force space activities remained remarkably constant during the first decade of the Space Age. In its first formal expression on military operations in space, the Air Staff in December 1959* had adopted the view that:

> the Air Force will develop orbital or "space systems" only if they show promise of: Performing an essential military mission more effectively at a justifiable increase in cost; or performing an essential military mission in an acceptable manner at a reduced cost over other methods of performing the same mission.[1]

[redacted] Eight years later, in a revision of USAF Planning Concepts (known also as The Plan, 1967-1982) the Air Force stated it would develop military space capabilities when space offered the only reasonable means to perform essential military tasks. Such capabilities would be aimed at countering unfavorable enemy action in that medium, exploiting opportunities to perform those missions that could be better done in space than in the atmosphere which could enhance Air Force operational effectiveness.[2]

[redacted] Thus, the Air Force found space a suitable medium to operate communication, and meteorological satellites that could not only support strategic operations but also facilitate tactical operations. Aside from these applications, the Air Force saw a clear need for extensive space research, development, and testing to further explore the military potential of space and prepare for any possible enemy technological advances.

[redacted] Even before the new planning concepts document was distributed in November 1967, the Air Force Systems Command (AFSC)

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*The Air Force had been cautious in declaring official space policy because of criticism it received when it organized the abortive Directorate of Astronautics in December 1957. [Max Rosenberg, The Air Force in Space, 1959-1960 (S), (AFCHO, 1962), p 13; Lee Bowen, The Threshold of Space: The Air Force in the National Space Program (S), (AFCHO, 1960), p 20.]

had surveyed new options in strategy offered by space technology. In July 1967 Gen. James Ferguson, AFSC commander, submitted to Gen. John P. McConnell, Air Force Chief of Staff, the results of a series of mission analyses his command had recently completed. They anticipated using space technology to support such vital activities as surveillance and warning, communication, navigation, missile strike reporting, data collection, data relay, missile basing, missile reprogramming, and aircraft penetration.[3]

[redacted] From its investigations, AFSC concluded the Air Force possessed the space technology to acquire new and improved systems. General Ferguson suggested to the Chief of Staff that National Command Authorities--if the Air Force could develop new operational concepts to match the new space technology--could be provided new policy options. As one example, the General believed that the concept of negotiating with an enemy while strategic operations were going on might be practical if U.S. decision makers could be provided hard information on the relative status of all strategic forces, after the initial exchange of strategic weapons. Strategic warfare could thereby acquire a new dimension. The AFSC commander thought it timely to examine how the nation might capitalize on the potential of its evolving space technology. He posed several doctrinal and conceptual questions, however, which required further investigation by the Air Staff and possibly the Strategic Air Command (SAC).

[redacted] General McConnell wholeheartedly agreed with the above views but, in light of the growing interaction between defense (including warning) and offense, he felt that the Aerospace Defense Command (ADC)* and the Military Airlift Command's Air Weather Service should also participate. On 12 August 1967 he directed DCS/Plans and Operations to investigate the issues, but on a somewhat broader scale.[4]

[redacted] Subsequently, the Air Force initiated a study of space technology to provide more options for strategic operations in the 1970's. Known as "STRAT-70," it was begun in December 1967 by the Directorate of Doctrine, Concepts, and Objectives with direct participation by ADC, SAC, and AFSC, and counsel from the RAND Corporation. STRAT-70's goal was to predict strategic operations required in the next decade and determine how space technology could improve their effectiveness.[5]

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*The Air Defense Command was redesignated the Aerospace Defense Command on 12 February 1968 [AFR 23-9, 12 February 1968, "The Aerospace Defense Command"].

[redacted] During the early months of 1968, the three major commands compiled and submitted data. AFSC's Space and Missile Systems Organization (SAMSO)* described in detail all U.S. weapon systems that might play a role in strategic warfare, as well as command and control systems contributing to their employment. ADC summarized parametric data relating to defensive systems, while SAC submitted similar information on offensive systems. From March through June, the STRAT-70 group met often in the Pentagon to collate research and study inputs from other agencies. By 30 June 1968 the group had completed the basic outline and started to develop a battle management plan.[6]

[redacted] By this time, AFSC had initiated another study akin to STRAT-70. Because of Air Force concern with surveillance and warning during fiscal year 1967, AFSC joined ADC to investigate the tracking of objects in space. The project, identified as SOS-70, was launched in January 1968 and completed in May. Its findings were to be incorporated into the final report of STRAT-70, which was to appear early in fiscal year 1969.+[7]

[redacted] Many factors had provided thrust to the STRAT-70 and SOS-70 studies. Chief among them, General McConnell explained, was the Air Force's belated recognition that the Office of the Secretary of Defense (OSD) would not approve an improved antisatellite system in the near future. Equally significant was the Air Force's instinctive belief that deployment of the Army's Sentinel antiballistic missile system, as announced by Secretary of Defense Robert S. McNamara in September 1967, would probably jeopardize the command and control system essential to the Air Force's cherished strategic deterrence mission. With respect to the former, General McConnell was "unable to convince the 'approval authority' that the nation faced a significant threat from satellite systems." He concluded that any substantial improvement to the nation's strategic and defensive forces would only come by defining the total

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*Effective 8 July 1967, Headquarters, Space Systems Division, and Headquarters, Ballistic Systems Division, were inactivated; Headquarters, Space and Missile Systems Organization was activated in their stead [Ltr 744n, AFOMO, 25 May 67, subj: Organization of the Hq Space and Missile Systems Organization and Certain Other USAF Actions].

+For treatment of SOS-70 in the context of other space projects, see Part II, Chapter VI.

threat and the proper missions and systems to counter it. Consequently, in addition to STRAT-70 and SOS-70, the Air Force initiated a Spacetrack* change proposal and a missile defense analysis as well.[8]

(U) The critical importance of the space surveillance mission to national security was emphasized in public statements by Air Force leaders during the year. At the annual General Electric Forum in the fall of 1967, Secretary of the Air Force Harold Brown was queried on the long range impact of space exploration on national security. He replied that space technology would affect areas important to national security such as support of the terrestrial forces and monitoring arms control agreements. The Air Force Secretary said that advancing space technology should facilitate development of information systems, which would influence the nature of future defense forces. Space systems could instantly furnish critical data otherwise unavailable to decision makers. Also, space systems such as Vela or its successor would enable the United States to detect violations of arms control and disarmament agreements.[9]

(U) Later in the year, Secretary Brown told a Congressional committee that he was not overly concerned that the Soviet Union might attack the United States with weapons from space. While conceding their technical capability to do so, he could not see how their use of actual weapons would be more advantageous than the use of ballistic missiles for the same purpose. Further, even though the psychological problems created by the Russian capability were real, their effect was also limited. "You cannot in the long run create a military effect with a purely psychological advantage," he said, "especially if it has military disadvantages." However, to keep the advantage purely psychological, Secretary Brown said the United States had to continue its surveillance and tracking of Russian space vehicles, and this the Air Force was doing.[10]

(U) General McConnell also publicly noted the importance of maintaining the Air Force's detection, tracking, and cataloging activities. In an address accepting the General Thomas D. White USAF Space Trophy from the National Geographic Society in May 1968, the Chief of Staff commented on Air Force military objectives in

*The USAF component of the Space Detection and Tracking System (operated by North American Air Defense Command).

space. Reaffirming "the nonaggressive intent of all our operations in the space medium," General McConnell declared that the United States also wanted to insure "that no potentially hostile nation developes an offensive capability against which we have no defense." For this reason, he said, the Air Force placed great importance on systems which could detect, catalog, and--where possible--determine the mission of space vehicles launched by other countries.[11]

II. SPACETRACK

[redacted] The USAF Spacetrack System consisted of a network of radars and optical devices linked to a processing center. Its mission was to detect all man-made orbiting objects and report them to the North American Defense Command (NORAD). The primary net included five radars and several cameras; an FPS-17 surveillance radar and an FPS-79 tracking radar at Diyarbakir, Turkey; another FPS-17 and an FPS-80 tracking radar at Shemya,, Alaska; a third tracker, an FPS-49A, at Moorestown, N.J.; and Baker-Nunn cameras at Edwards AFB, Calif., and Sand Island in the Pacific. Another camera was at Oslo, Norway, but operations had been terminated, and plans were in progress to relocate it. The system also received data from a cooperative FPS-43 tracking radar operated by the Eastern Test Range (ETR) at Trinidad in the West Indies. In addition, Ballistic Missile Early Warning System (BMEWS) radars also supported Spacetrack.[1]

[redacted] During fiscal year 1969 the Air Force expected to receive additional satellite data from an FPS-85 phased-array radar at Eglin AFB, Fla.* It also looked forward to overcoming developmental difficulties with an FSR-2 electro-optical sensor at Cloudcroft, N. Mex., which would contribute additional tracking data.+

[redacted] Although the Air Force had made a number of improvements in the Spacetrack system during the early 1960's, it became apparent that others were needed to keep up with the rising artificial satellite population. On 26 July 1967 the Air Staff documented the system's new requirements in a program change request (PCR) prepared for OSD.[2]

[redacted] The Air Staff in this PCR listed four options, but recommended approval of the least costly one. Under this option, it

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*Destroyed by fire in 1965 before it became operational, it was subsequently rebuilt. R&D testing of the radar began on 5 June 1968.

+The Air Force had begun, but failed to complete, R&D Category II testing on this facility in 1965. After intensive engineering analysis, the Air Force concluded there were serious deficiencies in the optical subsystems which were subsequently modified.

would modify some existing sensors, relocate others, install certain new radars, and also build a new Space Defense Center. Specifically, the Air Force requested authority to modify the Shemya radar in 1970, Cloudcroft's FSR-2 in 1971, and Eglin's FPS-85 and Moorestown's FPS-49A radars in 1973. New FPS-85 radars were proposed for Ascension Island and for an undesignated spot in the Southwest Pacific in 1973. Assuming the FSR-2 prototype would finally prove its worth, the Air Staff also recommended installing the electro-optical devices in the United States, Spain, and South America in 1974 and, that same year, replacing the Diyarbakir radars with an FPS-85. It recommended building a new Space Computational Center in 1972 to supplant the existing Space Defense Center in the Cheyenne Mountain Complex. Finally, the change request included a new research program element--Space Object Surveillance, Tracking and Identification (SOSTI).* The projected five-year cost of the Air Force proposals was estimated at $441.14 million, of which $59.7 million would be needed in fiscal year 1969.

[redacted] Secretary Brown sent the program change request to the Secretary of Defense on 25 August 1967, even though he questioned the Air Staff timetable. On the same day, he asked the Staff to amend its schedule and prepare a master plan charting Spacetrack's evolution. In his memorandum to the Secretary of Defense, he requested $4 million in 1969 to improve processing and communication at existing sites; $3 million to modify existing space center facilities so that they could house an expanded central computing complex in lieu of installing a new facility costing $11 million; and $37 million for a new phased-array radar.+ Later, the Air Staff amended the change request and resubmitted it to OSD early in October.[3]

[redacted] On 9 December 1967 OSD approved modification of existing sensors. However, it deferred a decision on a new Space Defense Center and froze further expansion of the system pending completion of the Air Force master plan and various strategic and surveillance studies then under way. It also authorized $3.5 million

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*For the background on the SOSTI development, see Gerald T. Cantwell, The Air Force in Space, Fiscal Year 1967, Part I (S) (AFCHO, June 1970).

+This was the radar earmarked for Ascension Island. Secretary Brown thought further study might uncover a better location.

for SOSTI in 1969. A few weeks later, OSD deleted the $37 million in Military Construction Program (MCP) funds for the FPS-85 radar and the $3 million for the data processing facility. However, it reinstated the latter when Continental Air Defense Command (CONAD) made space available in its Cheyenne Mountain complex.[4]

[redacted] OSD's actions on the July 1967 change request left many requirements unsatisfied. Consequently, Secretary Brown signed another change request on 10 June 1968, which validated earlier stated needs and added a new item. This was a Space Analysis and Intervention Display and Evaluation System, a CONAD requirement suggested by Deputy Secretary of Defense Paul H. Nitze. By automating several manual analytical processes, the system would enable the Space Defense Center to acquire and display space data almost instantly in a convenient format for timely analysis.[5]

[redacted] The items covered by the two change requests supplemented earlier Air Force recommendations for Spacetrack improvements. In September 1967 OSD had approved modifying the FPS-85 at Eglin AFB as a backup facility to the Space Defense Center. This conversion required secure communication circuits and terminals linking the Center, the FPS-85, and other Spacetrack sensors. Also, in October 1967, OSD financed modifications for two other Spacetrack radars. The FPS-80 radar at Shemya, Alaska, was to be tied into

to achieve more positive identification of targets. Also, the radar at Diyarbakir, Turkey, was to be improved by adding a rapid on-site data processing capability.[6]

[redacted] Meanwhile, following a project review, Air Force and OSD officials decided to continue developing the FSR-2 electro-optical facility at Cloudcroft.[7] Their decision was based on ADC's estimate that the FSR-2 would substantially improve Spacetrack's operational capability. Existing radars had ranges under 4,000 nautical miles (NM). To expand these by increasing transmitter power and enlarging antenna diameter was technically possible but financially prohibitive. On the other hand, the electro-optical sensor could reach out to orbiting objects at synchronous altitudes of about 22,000 NM. On 9 August 1967, Dr. Alexander H. Flax, Assistant Secretary of the Air Force (Research and Development) requested OSD's approval to continue the FSR-2 project--describing a two-phased program of studies, development, and test. On 11 November 1967, Dr. John S. Foster, Jr., Director of Defense Research and Engineering (DDR&E) approved $2.2 million for the project.[8]

[redacted] For a number of years the Air Force had wanted to move its Norwegian-based and Sand Island Baker-Nunn cameras to more efficient locations and to deploy a fourth camera held in storage. Its original intention was to relocate the instrument at Oslo to Spain. However, this plan was abandoned in July 1967 when the U.S. ambassador pointed out the political climate in Spain was unfavorable for seeking modification of the base rights agreement. Subsequently, the Air Force investigated possible locations on some U.S.-operated base in Italy. ADC recommended San Vito Air Station, near Brindisi, and asked Headquarters USAF to initiate the necessary action to obtain approval from the Government of Italy. No problems were anticipated and at year's end the Air Staff requested OSD to provide the necessary minor construction funds.[9]

[redacted] Similarly, by June 1968 the way finally seemed clear to move the camera in storage to Mount John, New Zealand, when the Air Force accepted minor exceptions to its standard policy on foreign base agreements. University of Canterbury officials, on whose land the instrument would be located, signed the land lease on 22 February 1968.* The Air Force requested bids for the site construction package in May and expected country-to-country agreements to be signed in July.[10]

[redacted] The Air Force was also interested in moving the Sand Island camera to another location in the Southern Hemisphere. On 26 December 1967 the Government of Australia agreed to permit site surveys beginning March 1968. Although a number of sites were attractive, late in March an ADC survey team recommended selection of Perth because of a more favorable construction cost market and better family accommodations.[11]

[redacted] Meanwhile, ADC moved to fill the gap in coverage until cameras were in place at Mount John and San Vito Air Station. The Smithsonian Astrophysical Laboratory had operated a Baker-Nunn camera at Jupiter, Fla., until budget cuts closed the operation. ADC therefore suggested to Headquarters USAF that Jupiter be used as a temporary location for a camera. On 4 January 1968 the Air Staff agreed, and the camera that had been at Oslo was moved to Jupiter, where ADC put it into operation on 6 June.[12]

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*University officials wanted a seven-year lease and the right to unilaterally settle all disputes with its tenant. Normal Air Force policy called for a maximum five-year lease and resolution of difficulties through diplomatic channels.

III. SATELLITE COMMUNICATIONS

(U) By July 1967 the modest study effort begun by the Air Force a decade earlier to explore the feasibility of communicating by means of satellite relay had evolved into two active programs. One was a 17-satellite, operational point-to-point, or strategic communication satellite (COMSAT) system; the other was a functioning single-satellite, tactical communication demonstration project.*

[redacted] On 1 July 1967 the Air Force successfully launched six satellites into circular, near-synchronous orbits, three of them components of the Defense Satellite Communication System (DSCS).+ Thirteen days later, the Defense Communications Agency (DCA) declared the Pacific network of 17 satellites operational. Measuring 36 inches in diameter and weighing 100 pounds each, the satellites provided White House and OSD officials with five different continuous voice circuits for direct contact with U.S. Commanders in Southeast Asia via terminals in Hawaii and South Vietnam. When eight more satellites were successfully launched on 13 June 1968, bringing to 25 the total number of near-synchronous satellites in orbit, Phase I of system acquisition was completed.[1]

[redacted] On 1 July 1967 the Air Force assumed responsibility for the MSC-46 ground satellite terminal at Clark AB in the Philippines, the first of seven it would eventually control. It was scheduled to operate several others in Colorado, Turkey, and Alaska, as well as contingency terminals whose locations had not been determined by the Joint Chiefs of Staff (JCS). Later in the year, the Air Force accepted a terminal at Wildwood, Alaska, and one at Brandywine, Md.

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*A "strategic" system consists of small, low-powered satellites operated in conjunction with relatively large, fixed ground terminals. Conversely, a "tactical" net requires large satellites with sufficient power to relay information to small, mobile terminals carried by ships, tanks, jeeps, trucks, and aircraft.

+The three other satellites included Lincoln Experimental Satellite 5 (LES-5), a Department of Defense (DOD) gravity gradient experimental satellite, and a despun antenna test satellite.

[redacted]

[redacted] While the Phase I satellite system was being established, defense agencies were trying to iron out a few remaining unsettled details concerning Phase II. With regard to the launches, the Air Force proposed to orbit six Phase II satellites with a single Titan IIIC booster. Not sharing the Air Force's faith in its big booster, however, DCA hesitated to endorse this approach. As it turned out, other considerations helped resolve this question. To be compatible with the more powerful Phase II satellites, the original DSCS ground terminals required extensive modification. Since the changes could not be made on all terminals simultaneously, it was apparent that orbiting all the satellites at the same time would waste useful satellite lifetime. Consequently, DCA decided to launch the satellites in groups six months apart.[2]

[redacted] A related question concerning satellite procurement was resolved during the year-long evolution of the DSCS Phase II Development Concept Paper (DCP).* Preparation of this document had been delayed late in the preceding fiscal year, when Secretary McNamara reopened the issue of leasing instead of buying satellites outright. He had directed DCA and the Air Force to evaluate a Communications Satellite Corporation (ComSatCorp) proposal to lease satellites to the government. However, since the unexpectedly long lifetime of the Phase I satellites allowed more time for a decision, the matter was still unresolved when fiscal year 1968 opened.[3]

[redacted] The Air Force objected to the initial drafts of the paper, believing the DCP approach too restrictive. Specifically, Secretary Flax protested that the paper did not clearly explain all the advantages and disadvantages of each of three procurement options; i.e., leasing satellites, normal procurement of satellites specifically intended for Phase II, or procuring duplicates of the satellites the Air Force was developing for the United Kingdom.+[4]

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*The DCP, prepared in the Office of the Director of Defense Research and Engineering (ODDR&E) with service assistance, was described by Dr. Foster as a "summary top management document" whose purpose was "to help the Secretary of Defense make decisions on major programs throughout their development life." The paper presented "the continuing rationale for each program, its full military and economic consequences, and the risks involved in each decision.... [See testimony of Dr. Foster, 7 Feb 1968, in Hearings before Senate Cmte on Armed Services, 90th Cong, 2d Sess, Authorization for Mil Proc R&D, FY 1969, and Reserve Strength, p 419.]

+The United Kingdom satellite project is described below.

[redacted]

[redacted] It was not until 12 February 1968 that Secretary Flax concurred in the fifth draft of the concept paper, although he felt that the British satellite alternative was still not clearly presented. In the final version of the DCP sent to the Secretary of Defense on 6 June 1968, Dr. Foster recommended procurement of six improved satellites weighing 950 pounds each. Much larger and heavier than the satellites in the original Phase II plan, they were to be launched two at a time aboard a Titan IIIC booster into synchronous orbits. The satellites would be equipped with both earth-coverage and narrow-beam antennas. The former would allow fairly uniform coverage of that portion of the earth which the satellites could scan, while the latter could "spotlight" particular parts of the earth. The satellites would be protected (hardened) against radiation and would include secure command and data circuits. Dr. Foster's proposal, which also provided for acquiring 30 additional ground terminals, rejected any satellite leasing arrangement or procuring the British models.[5]

[redacted] The Air Force would have preferred faster acquisition of the space segment than proposed and an additional 78 terminals. However, both Dr. Flax and Brig. Gen. Walter R. Hedrick, Jr., Director of Space, accepted the economic realities which dictated the lesser alternative. If SAMSO could get its request for proposals to industry by early August, contracts could be let in February 1969. At the end of fiscal year 1968, Secretary Nitze had signed the development concept paper, and Dr. Gardner L. Tucker, Deputy Director, DDR&E for Electronic and Information Systems, informed the House Committee on Government Operations that DOD was going ahead with Phase II. However, no formal word had been passed to the Air Force.[6]

[redacted] Meanwhile, during the summer of 1967 a test conducted at the request of ODDR&E confirmed that the DSCS could instantly transmit from Vietnam to Washington. On 26 September 1967 the JCS generally concurred in a DCA plan prepared for ODDR&E to acquire an interim operational capability. During the test phase, a Navy R&D facility at Waldorf, Md., had been the Washington terminus. The JCS now identified Brandywine, Md., where some communication equipment was already located, as the site for the operational system's Washington area terminal. The interim operational system would comprise an MSC-46 terminal operated by the Army in Saigon, the MSC-46 at Brandywine (to be installed and operated by the Air Force), and a relay of two back-to-back MSC-46's at Pacific Command Headquarters in Hawaii.[7]

[redacted] Construction on the Brandywine terminal began on 13 October 1967 and was completed by 15 December. Simultaneously, Philco-Ford was awarded a contract to install a

The system's initial operations schedule called for routine transmission four hours a day, five days a week, with emergency use at any time. This link became operational about 15 January 1968. An MSC-54 terminal also was completed at Brandywine on 8 May to serve as a backup to MSC-46.[8]

[redacted] Besides playing a key role in U.S. satellite communication projects, the Air Force supported United Kingdom (U.K.) and North Atlantic Treaty Organization (NATO) ComSat programs. In 1966 DOD had agreed to procure and orbit two improved DSCS-type satellites for the British. One satellite would be on orbital standby should the other fail; however, traffic would be routinely shared between the spacecraft as long as both were operable.

[redacted] During fiscal year 1967 the Air Force had questioned the amount of technical data to which the British were entitled. After several agencies investigated the matter, OSD reassured the Air Force that there was no conflict between the international agreement and pertinent U.S. National Security Memoranda. The agreement clearly obligated DOD to provide the British the same developmental and production information deriving from British-funded activities that the United States would have obtained had it funded the work. Otherwise, the Air Force need release only that data essential to effective U.S.-U.K. cooperation. In December 1967 the Secretary of Defense approved arrangements made by military representatives of the two countries to achieve interoperability between the two national systems.[9]

[redacted] A bidding competition restricted initially to British subcontractors during fiscal year 1967 failed to evoke responsive bids for the ground satellite control terminal. The Air Force therefore on 3 October 1967 requested new proposals and subsequently selected an American firm, Radiation, Inc., to do the work. The firm conducted preliminary design review of the ground system at its Florida facilities on 17 June 1968. Meanwhile, the spacecraft manufacturer, Philco-Ford ran into problems in developing the U.K. satellite, resulting in slipping the first launch from November 1968 to April 1969.[10]

[redacted] On 7 September 1967 OSD advised DCA and Secretary Brown that NATO had agreed to proceed with Phase II of its satellite communication project, which would include procurement and launch of two U.K.-type satellites and acquisition of an appropriate number of ground terminals. The NATO Infrastructure Committee had agreed to provide $3 million for a 180-day option to procure the satellites and Supreme Headquarters Allied Powers Europe (SHAPE) authorized the United States to obligate this money immediately, with additional funds to follow. OSD assigned primary responsibility for U.S. participation in the project to the Director of DCA and asked the Secretary of the Air Force to procure the satellites as an add-on to the existing U.K. satellite contract. Despite these instructions, the Air Force moved very slowly on the procurement. It did not commit funds until 4 April 1968, after the Infrastructure Committee had authorized SHAPE to issue a letter of intent for purchasing the two satellites.[11]

(U) The start of fiscal year 1968 also saw the Air Force and OSD reach a milestone in the tactical communication satellite area. On 1 July 1967, LES-5 was launched into its 18,000-NM, near-synchronous orbit. The first of two satellites developed by the Lincoln Laboratory of Massachusetts Institute of Technology under Air Force Program 591, LES-5 sought to demonstrate the feasibility of teletype communication in the UHF spectrum between terrestrial* terminals via satellite relay. The satellite was spin-stabilized, solar-powered, and the first to employ only solid transistors in lieu of vacuum tubes. Radiating about 50 watts, the satellite drifted around the earth once every 11 days.[12]

(U) Immediately after launch the Air Force, Army, and Navy began using the satellite. For its portion of tests aimed at proving the operational usefulness of satellite relay of teletype data between aircraft for command and control, the Air Force had modified 12 aircraft (six EC-135's, three B-52's, and three KC-135's). The Army had prepared five experimental ground stations, and the Navy three experimental shipboard terminals and three shore installations.

[redacted] During the first half of the year, Program 591 proved conclusively that satellite communication between aircraft and

*The word "terrestrial" as used here denotes airborne, seaborne, and ground terminals as opposed to spaceborne terminals.

[redacted]

from aircraft to ground was feasible and reliable. The test program entered Phase II on 1 January 1968. As the principal Air Force user, SAC flew a Thule monitor mission* to test the maximum range and operational error of the satellite system, as well as the effect of heavy Aurora Borealis on transmissions. Tests between the Offutt AFB aircraft and those in the Alaska and Greenland areas showed that reliable communication could be maintained as far north as 75°, about the latitude of Thule. After SAC completed its tests during March, AFSC arranged for modification of the SAC terminals for use with LES-6. At a meeting at SAMSO later that month, all participants expressed "high enthusiasm" over LES-5 results. By 30 June 1968 the Air Force completed its use of the satellite. However, testing by selected NATO countries was to continue into the new fiscal year. Also, the United States began negotiations with Japan for a data exchange agreement.[13]

[redacted] As the testing of LES-5 neared its end, the Air Force prepared to launch LES-6, the second Program 591 satellite, early in fiscal year 1969. More advanced than its predecessor, LES-6 would operate at synchronous altitude, have more electrical power, and be able to beam its signals more efficiently to receiving terminals.

[redacted] In addition to the Lincoln Laboratories satellites, the Air Force also was responsible for furnishing two R&D satellites--TacSat 1 and 2--Titan IIIC boosters, and launch services for the tri-service Tactical Communication Satellite Program, also known as Program 191. As originally planned, these satellites would be launched into synchronous equatorial orbits and be capable of a single repositioning of at least 180°. In January 1967, when the Air Force awarded a contract for the 1,600-pound satellites to Hughes Aircraft Co., it scheduled the launch of TacSat for the third quarter of fiscal year 1968. However, because ODDR&E insisted that the satellite command links be secured to protect them against possible Soviet tapping, the Air Force was forced to slip the launch to the first quarter of fiscal year 1969.[14]

[redacted] Meanwhile, the Army, Navy, and Marine Corps members of the Tactical Satellite Executive Steering Group (TSEG)+ were

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*SAC aircraft constantly visually monitored the BMEWS site at Thule, Greenland, to be certain that no communication outages could be erroneously attributed to an attack.

+For the background on the establishing of TSEG, see Cantwell FY 1967, Part I, pp 34-35.

[redacted]

studying various ways to assure the best operational use of the R&D tactical satellites. At the suggestion of the Air Force, the steering group directed the Army to take the lead in defining a system for handling known intratheater requirements, and the Air Force to study worldwide tactical satellite communication needs. During the fall of 1967 both service studies were submitted to TSEG. Meanwhile, ODDR&E and the Military Communications-Electronics Board (MCEB) submitted specific requirements which they wished included as a TacSat operational plan.[15]

[redacted] Neither the Army nor Air Force studies reflected all ODDR&E/MCEB requirements. The steering group therefore accepted another Air Force suggestion that the two service studies be integrated into a comprehensive operational concept plan. The Joint Staff also was asked to participate in drafting the plan because of JCS interest in it.[16]

[redacted] The concept plan furnished the Joint Staff on 15 March 1968 described a program for building an initial operating capability on LES-6, TacSat 1, and the TacSat 1A--as the TacSat 1 backup now became known. The operational configuration would be reached in three stages: by converting R&D assets to operational use, using the modified TacSat 1A and additional terminals in calendar year 1969, and deploying the TacSat 2-based system starting in calendar year 1972.[17]

[redacted] The steering group suggested that launching TacSat 1A would be the most efficient way to increase the availability, reliability, and survivability of communication in combat. It pointed out that major components had been designed, some satellites already produced, and technology existed to make necessary modifications. Any new satellite would cost more and would certainly not be ready for operational use before calendar year 1971.

[redacted] Members of the Joint Staff had reached similar conclusions, particularly regarding Southeast Asia requirements. Since 1962 DOD had invested $320 million in fixed-plant, long-haul communication facilities in Southeast Asia, yet in March 1968 the network still was unable to fulfill requirements. However, the Joint Chiefs were now convinced that a satellite communication system--composed of satellites with steerable narrow beams and enough terminals to support contingency requirements--could meet any future needs. Either the DSCS Phase II or the TacSat system could fulfill these criteria. However, OSD had not approved the former, and the latter was still in the early stages of development. If Phase II of the DSCS

was funded immediately, it still would not be able to meet increased SEA requirements before July 1970. It appeared this long delay could be avoided, however, by modifying TacSat 1A so that it could be used with the DSCS and linked to six MSC-54 terminals. Such a system, which could become available about a year earlier, would probably cost much less, be more flexible, and its space and terrestrial components could be adapted to other uses.[18]

[redacted] The Space Directorate, whose representatives had participated in all this planning, agreed the above was a logical approach to the tactical satellite program. The greatest utility would be derived from TacSat 1, and this course of action would lead to an early significant operational system at a low technical risk. Equally significant, if the TacSat 1 program was approved, the major acquisition effort for TacSat 2 could be deferred until fiscal year 1971. Accordingly, the Directorate estimated on 1 April 1968 that 1970 funds could be reduced from $37 million to $3.5 million.[19]

[redacted] Meanwhile, in January Dr. Flax reviewed and suggested some changes in a TacSat DCP prepared by ODDR&E and on 7 February he concurred in the final draft. The entire subject was addressed in detail in TSEG's formal Tactical Satellite Communication Operational Concept Plan, submitted to the JCS and to the military departments on 15 March. Various formal briefings were subsequently given to staff elements of the departments and ODDR&E. At year's end, actions were under way to submit a formal TacSat concept formulation phase proposal to OSD.[20]

(U) During the fiscal year, the steering group agreed on a division of responsibilities for TacSat 1 R&D testing. All testing would be controlled from the Army's Satellite Communication Test Operations Center at Fort Monmouth, N.J. The Air Force would provide the overall Test Director, the Army and Navy, the Deputy Test Directors. On 12 June 1968 the group approved the preliminary draft of the Joint Services Test Plan for TacSat 1, prepared under Navy leadership. At the end of the fiscal year, the Navy was working on details of the plan.[21]

[redacted] The Air Force during the year also explored ways to provide the 27 EC-135 aircraft of the Worldwide Airborne Command Post (WWABNCP) system an early operational satellite communication capability. These strategically important aircraft depended on ultra high frequency (UHF) radio links for their primary means of communication. UHF transmissions, however, are interrupted whenever the

curvature or topography of the earth comes between sender and receiver. This difficulty could be overcome by satellite relay of UHF signals.[22]

[redacted] After studying the various options, on 24 May 1968 AFSC recommended that the Air Force conduct a limited industry contract competition to select a firm to install 27 new terminals and 54 modulation/demodulation devices aboard the airborne command posts.* In June the Air Staff directed the Air Force Logistics Command to initiate procurement and released $2.05 million in 1968 funds for the purpose. Aircraft modification was to start in the first quarter of fiscal year 1970 and end six months later. Since launch time for both LES-6 and TacSat 1 would precede the modifications, the worldwide airborne command posts would be able to benefit from the UHF satellite communication relay system by late fiscal year 1970.[23]

*The competition was to be limited to two contractors, Electronics Communications, Inc., and Collins Radio.

IV. SUPPORTING TECHNOLOGY AND PROGRAMS

(U) In addition to the satellite systems and programs described in earlier chapters, the Air Force carried on many ground-based activities to support its space endeavors. It also continued to investigate many related technologies which could be used to improve space systems in the future.

Space Experiments

(U) The inevitable merger of the Air Force's Aerospace Research Support Program (ARSP) and Space Experiments Support Program (SESP) took place in March 1968.* The former had been established in 1962 by the Office of Aerospace Research (OAR) to coordinate efforts to place research and exploratory development experiments aboard available boosters. SESP had been organized by the Air Force in 1966 under AFSC to serve advanced and engineering development programs.

(U) On 12 March 1968 General Hedrick sent AFSC and OAR a plan which merged three related activities into two. Beginning in fiscal year 1970, Systems Command's SESP office would be responsible for locating empty "piggyback" space aboard large boosters which could be used for general DOD research and technology experiments. It also would be responsible for payload integration and launch services. ARSP would be dropped and its research satellites and sounding rockets projects combined with OAR's Plastic Balloon Components and Techniques program under a new element. This new program, entitled Satellites, Balloons, and Rockets, would be managed by OAR.[1]

(U) Under provisions of the Directorate of Space plan, OAR and AFSC would retain the same division of responsibilities through fiscal year 1969. As in the past, any military agency could sponsor experiments, but since SESP operated with R&D funds, sponsors of non-R&D payloads were expected to finance integration costs and

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*For further background, see Cantwell, FY 1967, Part I Chapter VIII.

payload-peculiar charges. The Directorate of Space would handle all flight requests, advise the AFSC program office on flight plans, and annually host a program review.

(U) During fiscal year 1968 flight attempts in the two programs again were marked by checkered success. ARSP attempted to place seven spacecraft and 26 experiments into orbit. On 27 July 1967 an Atlas D launched from Vandenberg AFB carried three orbital vehicles: OV1-11, OV1-86, and OV1-12, with six experiments aboard. OV1-11 failed to orbit; the other two, carrying radiation experiments, were successful. The following day an ARSP ultraviolet radiation sensor was carried piggyback into orbit by a TAT-Agena D launched from Vandenberg. On 4 December 1967 one of OAR's Scout boosters launched OV3-6, carrying into orbit two ionospheric study experiments. On 6 April 1968 an Atlas F was used for the first time in support of ARSP, placing OAR's OV1-13 and 1-14 into orbit. OV1-13 contained seven radiation experiments, a solar cell experiment, and a National Aeronautics and Space Administration (NASA) materials test. The other orbital vehicle carried eight SAMSO radiation experiments.[2]

(U) Two background radiation experiments and one solar X-ray burst detector experiment were successfully carried aloft from Vandenberg on 7 August 1967 by an Air Force Long Tank TAT-Agena. An Army geodetic experiment was lost during the launch of NASA's Nimbus B weather satellite on 18 May 1968, when the Vandenberg AFB range safety officer destroyed the errant Thorad booster.[3]

(U) The Air Force planned two additional SESP launches carrying 14 experiments early in fiscal year 1969. ARSP's remaining two flights, planned for July and December 1968, would carry five experiments. During fiscal year 1968 the two programs received a total of $17.2 million. The 1969 DOD budget submitted to Congress requested $6 million for ARSP and $16.5 million for SESP.[4]

Space Boosters

[redacted] In mid-February 1968 the Air Force's Designated Systems Management Group reviewed the status of the Titan III R&D space booster and agreed that it had achieved its objectives. As a result of this program, initiated in December 1962, the Air Force acquired a family of standardized boosters to support national space projects. Initially, the Air Force developed two models, which used

as building blocks components of the Titan II ICBM liquid propellant first and second stages, a restartable upper stage (transtage), a control module, and two strap-on 120-inch solid propellant rocket motors. The initial configuration, Titan IIIA, consisted of the liquid core, transtage, and control module; it could place 5,800 pounds into a 100 NM orbit. The second, Titan IIIC had 86-foot solid rockets strapped on and could lift 5,000 pounds to escape velocity, put 2,140 pounds into synchronous equatorial orbit; or it could place 25,100 pounds into a 100 NM circular orbit.[5]

[redacted] The Titan III family continued to grow. During fiscal year 1965 OSD had approved an Air Force proposal to develop Titan IIIB. This was a stripped-down version of the "A," without its transtage, malfunction detection system, and certain redundant equipment. The "B" was required to orbit specially classified payloads from the West Coast which the Atlas-Agena could not handle. Following a single developmental launch on 29 July 1966, the "B" was declared operational on 28 September. The "M" model was approved in fiscal year 1966 with modified, first-stage engines and seven-segment solids as the booster for the Manned Orbiting Laboratory. In April 1966 the Air Force also was authorized to develop the Titan IIID to meet special polar-orbit mission requirements. Its components included two-segment strap-on motors, radio guidance (all other Titan III models had inertial guidance), and Burner II in place of the transtage. In accordance with production contracts negotiated late in 1967 and early in 1968, 98 percent of the parts in the Titan IIIB, C, and D models would be standardized.[6]

[redacted] During fiscal year 1968, Air Force crews launched five more Titan IIIB's at Vandenberg AFB, bringing to 13 the number of successful shots in 14 attempts. As discussed earlier, two Titan IIIC's launched from Cape Kennedy successfully placed their communication satellite payloads into orbit, for a record of eight successes in 10 tries. With development of the "D" proceeding, on 3 May 1968 the Air Force awarded a contract to M. M. Sundt Construction Co., to modify Space Launch Complex 4E at Vandenberg. The work was to be completed by 16 May 1969, well ahead of the first Titan IIID launch scheduled for July 1970.[7]

[redacted] Requirements for another important Air Force booster, the SLV-2 (Thor), diminished in fiscal year 1968. During the previous year, ODDR&E had approved procurement of 29 SLV-2's to meet USAF and NASA needs through June 1969. In December 1967 an Air

Force review of 1970 requirements revealed that 12 vehicles would satisfy the needs of both agencies. The Air Force planned to use only two of the Thors.[8]

(U) Also, it appeared that unless NASA came up with a requirement, production of the SLV-3 (Atlas)--one of the space age's early workhorses--might end in September 1968. The last Atlas was due for delivery at that time, and AFSC could identify no further USAF requirement. Certain Air Force programs used surplus Atlases, but none required the SLV-3 configuration.[9]

[redacted] Changes also were made early in fiscal year 1968 in Air Force procurement plans for the Agena space booster,

If NASA identified new requirements, it would procure the Agenas directly from the contractor.[10]

The Satellite Control Facility

[redacted] Although its budget was reduced by almost 20 percent, the Satellite Control Facility (SCF) achieved most of its projected improvements in fiscal year 1968, with only one item, a new antenna, being canceled outright. In the revised RDT&E budget, the Air Force withheld complete funding of the SCF's new Guam tracking station until fiscal year 1968, reduced base support to the lowest acceptable level, and made other changes.[11] Meanwhile, construction began on the Guam facility in July 1967, aiming for operational capability in April 1969.* All available funds were applied to work on the facility's new 60-foot antenna, which would be temporarily connected to the old mobile tracking station in order to support a launch set for December 1968.[12]

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*The facility originally was to have been completed by July 1968. It would include a Space Ground Link Subsystem (SGLS), an Advanced Data System (ADS), and improvements to the Expanded Communications Electronic System (EXCELS).

[redacted] By 1 August 1967 OSD accepted an Air Force proposal to resolve the communication logjam at the Indian Ocean Station by tying it into the DSCS. AFSC was authorized to lease two terminals for installation at Antigua, British West Indies, and Mahe, Seychelles island group in the Indian Ocean. With the completion of work in the summer of 1968, the vital Indian Ocean Station would be linked to the Satellite Test Center, Sunnyvale, Calif., by two data and two teletype circuits and one alternate voice/data circuit. At least one of the slowly drifting DSCS satellites would be in proper position for the two terminals to use it about 75 percent of the time. Otherwise, the station would revert to high frequency transmission.[13]

[redacted] In August 1967 Congress finally approved an Air Force request ~~to~~ purchase 8.2 more acres of land for the Satellite Test Center at Sunnyvale. Site preparation began in October, but OSD fund restrictions delayed actual construction of the facility until 15 March 1968. The slippage of the completion date to July 1969 was expected to have no impact on operations. However, it would delay installation of certain equipment and increase the facility's costs since procurement would have to be extended and contracts changed.[14]

Lifting Body Spacecraft

[redacted] In July 1967 the Air Force's Spacecraft Technology and Advanced Reentry Tests (START) program consisted of two projects-- Piloted Low Speed Tests (PILOT) and Maneuverable Reentry Systems (MRS) studies. Two other projects, Aerothermodynamic/elastic Structural Systems Environmental Tests, and Precision Recovery Including Maneuvering Entry (PRIME), had been successfully completed during fiscal years 1966 and 1967, respectively. The three-flight PRIME project proved that an ablatively cooled, maneuverable reentry vehicle capable of Mach 5 speeds over a range of 4,500 nautical miles could return to the earth's surface within 10 miles of its objective, and that it could be refurbished and reused. The unmanned SV-5D vehicle had performced cross-range maneuvers up to 700 miles.[15]

[redacted] The PILOT project called for testing a manned, low-speed version of the SV-5 configuration, which the Air Force designated the X-24A. Its data, collected in a flight regime of Mach 2 at 100,000 feet and landing, would supplement information obtained from the earlier PRIME tests. The project would correlate pilot experience with wind tunnel data, simulator techniques, and the experiences of NASA's HL-10 and M2F2 lifting bodies, also undergoing tests. For that matter

PILOT flight tests were coordinated by the joint NASA/DOD Lifting Body Flight Test Committee, formed in April 1965 to oversee the NASA programs.*

[redacted] The X-24A flight tests were to be conducted in two phases. The first, to begin early in fiscal year 1969, would comprise 10 subsonic, unpowered flights initiated by a B-52 drop. In the second phase of 20 flights, the pilot would use the vehicle's rocket power to attain transonic and supersonic speeds approaching Mach 2 to investigate and measure stability characteristics under human control.

(U) Accepted by the Air Force on 24 August 1967, the X-24A completed full-scale wind tunnel tests during February and March 1968 at NASA's Ames Research Center to verify results of earlier small-scale tunnel tests. While confirming previous X-24A lift/drag and stability values with a smooth surface, the tests showed that both suffered significant losses when the craft's surfaces were roughened to simulate post-reentry condition. An additional wind tunnel program was then undertaken to compare the recovered PRIME vehicle shape with the unflown X-24A to evaluate those effects. As a consequence, although all flight test instrumentation had been installed, the flights were delayed until about September 1968.[16]

(U) In December 1967 ODDR&E pared the START's fiscal year 1969 budget from $4 million to $1 million and reduced the program to minimum X-24A testing and design studies and wind tunnel tests of Maneuverable Reentry Systems. In fact, ODDR&E considered the MRS technology effort the most important START task remaining. Since $600,000 was needed to support the X-24A, $400,000 was to be applied to competitive studies culminating in MRS preliminary design and aerodynamic development. A plan for MRS studies was requested in time for the fiscal year 1969 allocation of funds. The Air Force, however, succeeded in having $100,000 set aside for an expandable structures project (discussed below), reducing MRS funding to $300,000.[17]

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*A formal agreement dated 7 November 1967 provided that the X-24A and its spares, parts, and supporting materiel would be loaned by the Air Force to NASA for the tests.. The Director of NASA's Flight Research Center would manage the test program in consultation with the Chief, Research Properties Branch, Aeronautical Systems Division, AFSC. On 25 January 1968 the loan agreement was completed. Then on 13 May 1968 HQ USAF and NASA accepted the working level agreement proposed to implement the agency agreement.

[redacted] The Air Force's attempt to guide the MRS studies in a meaningful direction was greatly handicapped by its own inability to define a mission for the lifting body spacecraft. Reports completed in October 1967 by several contractors who had investigated MRS identified four possible missions: [redacted] logistic support of a space station, and routine and request surveillance. However, they saw no clear, pressing military need for such missions. Also, because of the priority demands of Southeast Asia on the Air Force's limited R&D funds, Dr. Flax did not feel any sense of urgency for a viable MRS program.[18]

[redacted] In March 1968 Col. Paul Baker, Jr., Chief of the Technology Division of the Space Directorate, realized that lack of a credible MRS concept formulation plan might kill the project, except for the X-24A. In an effort to crystallize the directorate's thinking on the problem, he proposed that the Air Force develop an MRS system with a lift/drag value of 2.0/3.0 and a multimission capability for both USAF and NASA missions. Colonel Baker sought a system that could return 20,000-pound payloads and land in any weather at any time of the day. It would require an onboard guidance system that could enable an MRS vehicle to rendezvous and be recovered on demand, a data management system capable of transmitting at extremely high rates, and a high-performance, maneuvering propulsion system capable of multiple restarts. The Space Directorate official also noted that such questions as landing mode and vehicle geometry required more attention. After discussing the above proposal, General Hedrick and Dr. Flax's staff agreed that the first step in breaking the logjam was to inform the Assistant Secretary about the current status of technology. Toward this end, the General instructed Colonel Baker to prepare an MRS white paper.[19]

[redacted] It was completed and forwarded to Dr. Flax on 3 May 1968. Besides providing the requested survey of technology, Colonel Baker traced the history of the Air Force's development efforts on lifting bodies. While asserting that the technology for a lifting body spacecraft system development was in hand, he could identify no clear, current need for such a craft but suggested that the requirement for a new generation of spacecraft should evolve in the next decade.[20]

[redacted] After he was briefed on 20 June, Dr. Flax agreed that a parametric study of MRS payloads should be made. He thought that the need would be in the 20,000-pound range, and that such factors as vehicle reusability, horizontal landing, and cross-range capability would have to be investigated. His Deputy for Requirements,

Dr. Michael I. Yarymovych, was instructed to prepare a list of technological aspects of the MRS to be considered in a work statement near the end of the fiscal year.[21]

[redacted] As noted above, the Air Force planned to allot $100,000 in fiscal year 1969 to the Expandable and Modular Structures project. This project was an outgrowth of AFSC's preparations early in fiscal year 1967 to place experiments aboard NASA's Apollo Applications Program flights.* The AFSC effort was supported by the MOL Program Office, which saw particular merit in an expandable airlock technology experiment. Such technology would be needed if the MOL mission eventually required frequent extravehicular activity.[22]

[redacted] Despite strong support from the MOL office and the Space Directorate, the airlock technology experiment was not funded in 1967 or 1968. In the spring of 1968 the Space Directorate, still supported by the MOL Program Office, decided on a new approach and proposed incorporating the experiment into the START project in 1969. Although Dr. Flax questioned this move, on 21 March 1968 Dr. Yarymovych asked that he approve preparation of an expandable structures advanced development plan and that the project be included as a START program element in fiscal year 1969.[23]

Advanced Liquid Rocket Technology

(U) After 1968, when a small NASA contract would expire, the Air Force's advanced liquid rocket development effort would be the only such project actively being pursued in the United States. At the beginning of fiscal year 1968, it consisted of three projects: Advanced Storable Liquid Rocket Technology, High Performance Cryogenic Liquid Rocket Technology, and Advanced Maneuvering Propulsion Technology. On 19 January 1968, however, after a Phase I firing demonstration of the critical components of an advanced storable liquid rocket had been completed, ODDR&E decided to delay Phase II development because of funding problems.[24]

[redacted] The objective of the second project was to demonstrate a high pressure, liquid oxygen/liquid hydrogen (LO_2LH_2) engine.

Air Force officials believed that recoverable booster systems of the future would depend on the high chamber pressure LO_2LH_2 engine to obtain high performance with reasonably sized vehicles. In addition, their studies had shown that significant payload increases could be achieved by incorporating a high specific impulse engine using LO_2LH_2 into existing vehicle stages, or in future launch vehicles. During Phase I studies completed in 1967, researchers concluded that of two concepts investigated,* the high-pressure, staged, combustion bell type should be used to demonstrate a modular engine of 250,000 pounds thrust. The goal of Phase II, contracted with Pratt-Whitney on 6 November 1967, was prototype engine demonstrations beginning May 1971. In June 1968 this Air Force Reusable Rocket Engine was officially designated the XLR-129-P-1.[25]

[redacted] In November 1967 a contract was awarded to Rocketdyne to investigate Phase I of advanced maneuverable propulsion systems. Its overall objective was to demonstrate an advanced high performance, fully throttleable hydrogen/fluorine engine. Such a space vehicle engine would be important for such missions as surveillance, and docking. It also could be used in high-energy upper stage boosters. The Phase I investigations, requiring two years, would comprise preliminary engine design and testing of critical components.

Advanced Space Guidance

(U) Since 1962 the Air Force sought ways to improve the navigational capability of space vehicles. Under its Advanced Guidance project, it worked on inertial guidanced systems, horizon sensors, and star and landmark trackers. Fiscal year 1968 program activity, restricted by a shortage of funds, centered on the Flexible Guidance Software and Precision Earth Pointing Systems.+[26]

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*Also evaluated, but rejected as less technologically sound was an annular chamber-aerospike design.

+The Flexible Guidance Software System previously had been called the Quick Reaction Guidance and Targeting System. Precision Earth Pointing System had been the Space Precision Attitude Reference System. A third task, Horizon Data Measurement Set, restricted by fund cuts, was conducted at a very low level.

[redacted] Both were scheduled as SESP experiments to be flown in the second quarter of calendar year 1970. After the Air Force's request for $6 million for Advanced Space Guidance in fiscal year 1968 was cut in half in July 1967, a new development plan had to be prepared. Air Force officials nevertheless believed they could still meet major technological objectives and the flight date if ODDR&E promptly released deferred funds without waiting for the new development plan. Dr. Foster agreed and made the money available on 30 October 1967.[27]

[redacted] Lockheed, IBM, and North American Rockwell submitted competing preliminary designs for the Precision Earth Pointing System by April 1968. Each designed a stellar-inertial instrument which could give a spaceborne sensor its angular orientation with an accuracy of better than three to eight seconds of arc. IBM and Lockheed were selected to demonstrate their laboratory models. Because only limited funds would be available in fiscal year 1969, however, the Air Force decided it would select only one contractor to produce a flight prototype model.[28]

[redacted] In November 1967 the Air Force accepted a proposal from IBM to undertake Phase II development of the Flexible Guidance Software System. The project's major goal was to develop a mission planner compatible with Titan III. The planner's primary function would be to automate and reduce manual work of several contractors involved in Titan III prelaunch activities.[29]

[redacted] Fiscal year 1969 funding for Advanced Space Guidance work dropped from $8 million to $3 million. On 25 April 1968 SAMSO submitted new development plans in the form of R&D management reports, requesting Air Staff approval of the reduced effort.[30]

Advanced Space Power Technology

[redacted] At the beginning of fiscal year 1968 OSD reduced funding for the Air Force's Advanced Space Power Supply Technology program from the requested $3 million to $1.5 million. However, before the sum was released the Air Force was required to submit specific plans covering operation of a backup fuel cell system for MOL and a lightweight, high-powered solar cell array-battery power system for Program 191.[31]

[redacted] Dr. Flax forwarded these plans to DDR&E on 1 November 1967; they projected a three-year effort costing $6.8 million. Dr. Foster approved the plans on 22 November 1967, and granted the Air Force $700,000 for the fuel cell and $800,000 for the solar array in fiscal year 1968. However, since one bidder had challenged selection of a competitor to build the fuel cell, Dr. Flax authorized procurement of the solar array only, pending resolution of the issue.[32]

[redacted] The approved plan and associated development directive for the solar array cell-battery system outlined a two-year development effort costing $800,000 in fiscal year 1968 and $2 million in fiscal year 1969. Work was to start in April 1968 on a test model, which was scheduled for completion in June 1969, with initial flight set for the following November. In January 1968, however, OSD reduced the 1969 effort to $500,000 and stretched the program to 1970. In April $300,000 of the 1968 funds were deferred and allotted to another program. These 1968 and 1969 budget actions left only sufficient money for the array development; all effort associated with the battery power system was suspended. In June 1968 the Air Force awarded a contract to the Hughes Aircraft Company to produce the retractable solar array system.[33]

Navigation and Other Satellites

[redacted] In fiscal year 1967 the Navy was working on an expansion of its satellite navigation system, and the Air Force investigated the possible application of aircraft navigation by satellite. On 11 December 1967 ODDR&E approved an Air Force proposal costing $1 million in Space Studies funds to investigate a concept formulation of a satellite system for precise navigation of high-speed aircraft. After soliciting industry proposals for two studies, on 2 February 1968 the Air Force solicited the participation of the Army, Navy, NASA, and the Department of Transportation. On 29 February, Lt. Gen. Joseph R. Holzapple, DCS/R&D, invited these agencies to help evaluate contractor proposals and, later, contractor results. Subsequently, the Air Force also sent courtesy copies of the work statements to the Coast Guard, Marine Corps, and Federal Aviation Administration. In April the Air Force selected TRW, Inc., and Hughes Aircraft Company to undertake parallel nine-month concept studies of the proposed navigational satellite system, now identified as System 621B.[34]

[redacted] In February 1968 ODDR&E asked the military services to convert their Triservice Navigation Satellite Committee* to a Navigation Satellite Executive Steering Group (NSEG). Like the TSEG, the new steering group would be responsible for overall program coordination. Each Assistant Secretary for R&D was requested to appoint NSEG members from his own office and also from his military staff.[35]

[redacted] However, Dr. Flax sought to dissuade ODDR&E from adopting this particular management approach. Too many executive steering groups, he complained, were already consuming too much time of the "already heavily-burdened staff of the Service Assistant Secretary for R&D." Though excellent results had been obtained from TSEG, Dr. Flax thought the process would become self-defeating if it required more detailed management from the top, and would make it impossible to capture the high-level attention sought in the first place. Instead of another steering group, he recommended creating a coordination panel including representatives from the headquarters and systems/materiel commands of each service to perform the function. ODDR&E had not formally replied to Dr. Flax by the end of the fiscal year.[36]

[redacted] In May 1968 the follow-on DOD Gravity Gradient Experiment (DODGE) satellite project, to which OSD had attached great hope and expectation, was terminated. Early in fiscal year 1966, OSD had decided to adopt the Navy's DODGE project as a test-bed for meteorological experiments. Other subsystems experiments had been added, and, in April 1966, the Air Force was directed to place an infrared sensor aboard what had now become known as the DODGE-M ("M" for multipurpose) satellite. Disdainful of the project's usefulness in its own infrared satellite program and fearing the satellite would preempt booster space from more important satellites, the Air Force opposed the concept from the outset. It finally convinced ODDR&E in 1967 that time and events had negated the idea's rationale, and the infrared experiments were withdrawn. Within a year the entire project was dropped. At first the Navy had to suspend activity on the follow-on project, while it resolved orbital difficulties being experienced by the original satellite. Later it also was faced with funding problems. When the orbiting satellite achieved the project's original goals, Dr. Foster in May 1968 accepted a Navy recommendation to cancel the experiment.[37]

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*This committee had been formed by the military services in March 1967 as an ad hoc working group to make certain that any new satellite navigation system proposed would be cost-effective and triservice-oriented.

Space Studies

[redacted] In November 1962 the Secretary of the Air Force, Eugene M. Zuckert, had asked OSD for $25 million a year to finance space technology studies for which no other convenient or pertinent program element existed. Subsequently, OSD established Program Element 6.24.10.06F and allocated $10 million to it in 1964. However, the Air Force did not have autonomous control of the funds. ODDR&E released them incrementally for individual study projects and frequently transferred funds to other programs. Thus, in the four years up to 1968, although the Air Force was authorized $20 million for space studies, $14.98 million of that sum was diverted to other programs.[38]

[redacted] In August 1967 several contractor studies of "Economies in Spacecraft Operations" were completed. These studies had originated in January 1965 when ODDR&E asked the Air Force to find ways to reduce the cost of delivering and operating payloads in near-earth orbit. After a composite DOD/NASA mission model for the 1970-1985 period had been investigated, four of 10 proposed areas were isolated for further study. These were: extending spacecraft life; multimission spacecraft; improved launch vehicles; and launch-vehicle utility. Beginning in January 1966 five firms were awarded study contracts, which they completed by July 1967.[39]

(U) In November 1967 an Air Force contractor also completed the first phase of a space rescue study. This contractor concluded that, while most probably emergencies in space would not need an extremely rapid response escape system, they would produce crew injury. Hence, the operation of an escape device by an injured astronaut would be a significant consideration in defining an escape system. Examining these study results in the light of related work done by the Air Force, NASA, and the space industry, SAMSO concluded that here was a technical data base upon which deeper analysis of selected space systems could be made. Consequently, in February 1968 SAMSO requested $200,000 to conduct a Conceptual Design Analysis and Technology Assessment of Space Escape Systems.[40] No decision had been made on this request by year's end.

[redacted] During fiscal year 1964 Gen. Bernard A. Schriever, AFSC Commander, had personally attempted to arouse Air Staff support for studies of increased satellite survivability in a nuclear environment. While sympathetic to his position, the Air Staff could offer him no practical assistance at that time. Several years later,

in July 1967, having received encouragement from several civilian officials in ODDR&E and the Office of the Secretary of the Air Force (OSAF), AFSC asked for $1.9 million in fiscal year 1968 funds to complete a four-phased survivability study.[41]

[redacted] Despite the top-level support, AFSC's satellite survivability ideas were again cooly received by the Air Staff. In rejecting General Schriever's original proposals, the staff voiced the view that each system office should incorporate survivability into its own system. AFSC's new proposals were still broadly applicable to the "next generation of spacecraft." On that basis the Space Directorate recommended on 11 August 1967 that all but one project, be disapproved. It delayed a final recommendation on this project, which seemed technologically acceptable, pending identification of a source of funds. Should AFSC resubmit the other three projects, the proposed work would have to be redirected to a specific system or program element.[42]

[redacted] In the meantime, a joint Headquarters USAF/AFSC Systems Survivability Panel reviewed several Air Force satellite projects for vulnerability. It found no common basis for defining the nuclear threat or environment to which satellites might be exposed. It also pinpointed inconsistencies in required hardness levels of the different satellite systems. The panel felt all agencies dealing with satellite survivability should develop a general rationale for hardening, to include such matters as the threat, satellite survivability, tradeoffs, levels of hardening, and attendant costs. In referring the matter back to AFSC in October 1967, however, the Space Directorate suggested more emphasis on hardening during the RDT&E phase of satellite systems development. Nothing further came of the effort in fiscal year 1968, however. When Dr. Flax had not acted on the program within five months after its submission, in February 1968 the Directorate of Space recalled the program documents, intending to resubmit them for consideration in 1969.[43]

V. AIR FORCE RELATIONS WITH NASA

(U) As provided by the National Aeronautics and Space Act of 1958, DOD and NASA continued to closely coordinate their respective space activities during fiscal year 1968. Representatives of the two agencies sat together on the Aeronautics and Astronautics Coordinating Board (AACB) and its panels to assure the most efficient use of national resources. Key officials also discussed mutual problems on the Manned Space Flight Policy Committee and the Manned Space Flight Experiments Board. Elsewhere in laboratories, centers, and airbases, military and civilian operators collaborated on joint programs or observed each other's work in unilateral programs of mutual interest. The Space Act also stipulated that DOD make its resources available to NASA. As the department's agent in these matters, the Air Force provided the bulk of DOD support. During fiscal year 1968 Air Force support of NASA cost $160,906,602, of which $116,287,820 was reimbursable.[1]

(U) Only on the issue of reimbursement did the Air Force-NASA relationship sometimes tend to founder. Between 1963 and 1966 the Air Force had chafed under an OSD policy which provided support to the space agency on a generally non-reimbursable basis. Gradually OSD came around to the Air Force view that this was unrealistic, and on 2 November 1966 Secretary McNamara advised Mr. James E. Webb, Administrator of NASA, that he would adopt a policy of full recovery of DOD's costs in support of NASA. Implementing the new policy, however, proved to be a difficult matter.

(U) The problem was especially difficult at the Eastern Test Range-Merritt Island Launch Area complex. Here a joint working group had been appointed by the two agencies to work out an equitable cost-sharing arrangement. However, the group was unable to agree or recommend any reimbursement procedures to its parent organizations.[2] Faced with this impasse, on 4 April 1967 Dr. Foster and Dr. Robert C. Seamans, Deputy Administrator, NASA, submitted the issue to Mr. Charles S. Schultze, Director of the Budget, for arbitration. On 16 August 1967 Secretary McNamara advised that he would accept Mr. Schultze's decisions as binding and restated his current belief that both agencies should fully compensate each other for the costs of services rendered.[3]

(U) The Bureau of the Budget (BOB), after studying the issue, proposed a working formula on 28 February 1968. It established three cost categories for range activities: Management, Operations, and Support. In general, all costs peculiar to NASA were to be borne by the space agency regardless of category. DOD, as manager of the range, would pay for all costs associated with the management function. In fiscal year 1969 the Bureau decided that DOD would pay 60 percent of the overall cost of range operations, NASA 40 percent. However, in the case of Apollo support aircraft, NASA would fund 85 percent of their costs by virtue of a previous agreement. In the support area the space agency would continue to pay only for the direct support it received for its equipment and facilities.[4]

(U) Applying these guidelines, the Budget Bureau determined that, of the $269.9 million in planned ETR 1969 expenditures, the space agency should provide $51.4 million and DOD the balance of $209.5 million. The net effect of this decision would be to increase NASA's fiscal year reimbursement from a projected $30 million to $51 million. However, this was only an interim arrangement pending establishment of a more efficient range accounting system by the Air Force. The Eastern Test Range was the only area covered by the bureau's 1969 policy. Other activities were fully funded in each agency's budget on the basis of existing agreements and would stand, pending continuing discussions between DOD and NASA.

(U) In its implementing instructions to the Air Force in March, OSD directed that the new accounting and billing systems be installed by 1 July 1968 as suggested by the Bureau. With the waning of the fiscal year, it became obvious that the range could not meet this deadline; nevertheless, the Air Staff urged the AFSC commander to give the problem his personal attention.[5]

(U) Formal arrangements for Air Force support of NASA on the Western Test Range (WTR) had been put off for longer than a year awaiting resolution of the ETR impasse. When the anticipated BOB ruling covered only the ETR, ODDR&E and the Air Staff directed AFSC to resume negotiations with NASA on the WTR and seek maximum reimbursement. The command was also instructed to settle certain delinquent accounts receivable from NASA. These unsettled bills, some outstanding since mid-1966, covered WTR support to NASA's Nimbus, Pageos, and Delta operations.

(U) Aside from the overall question of Air Force support of NASA, there was another particularly vexatious issue at the Eastern

Test Range--reimbursement for launching commercial communication satellites. The first communication satellite intended for producing revenue had been launched at Cape Kennedy on 6 April 1965 when NASA orbited the Early Bird satellite for the Communications Satellite Corporation (ComSatCorp).* NASA performed various services for the corporation and provided much of the hardware involved. In turn the Air Force furnished the booster and rendered range and tracking services. Although reimbursed for the booster, the Air Force received no compensation for its range support. Misinterpreting an ODDR&E memorandum on the subject of support, the Air Force billed NASA for only $23,557.18, although the total cost of its services was $69,000.+6

(U) In fiscal year 1966, when additional ComSatCorp launches were imminent, the Air Force decided to correct the earlier billing and solicited Secretary McNamara's aid in obtaining full NASA compensation for costs of the forthcoming Intelsat II series. Secretary McNamara informed Mr. Webb that he concurred in the Air Force approach. Over Mr. Webb's objections, the Air Force billed NASA an additional $423,685.82 for the cost of the Early Bird launch. Moreover, on 24 April 1967 McNamara told the space agency chief that he had decided to charge NASA the full cost of launches following Early Bird. By this time, however, three launches in the Intelsat II series had already taken place--IIA in October 1966, IIB in January 1967, and IIC in March 1967. Secretary McNamara demanded retroactive adjustments.[7]

(U) On 14 September 1967 Dr. Joseph V. Charyk, President of ComSatCorp, appealed to the Secretary of Defense to reconsider. Rejecting the Air Force view that Intelsat II was a commercial system, he insisted that it was clearly a further developmental step essential for the establishment of an operational, global communication satellite system. That this system could derive operating revenue did not change its essential development character. Dr. Charyk added that should NASA pass on additional retroactive billings to ComSatCorp and the International Tele-Communications Satellite Consortium (Intelsat) it represented, the costs of launches would surpass the estimates the U.S. government had given the corporation. He

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*Two earlier industry-owned satellites, Telestar 1 and 2, launched in July 1962 and May 1963, had been developmental versions.

+See Cantwell, FY 1967, Part I, pp 9-14.

also claimed these estimates had been an important factor in developing the Intelsat and ComSatCorp charges to their customers for service. Hence, ComSatCorp's charges for DOD service in the Pacific were predicated in part on the launch cost estimates provided by the department.[8]

(U) Dr. Charyk offered several legal, commercial, and political reasons why the government should not impose such charges on Intelsat, particularly the retroactive costs. The corporation disagreed that the Budget Bureau required the government to recover full costs, asserting that this was discretionary with the contracting agency. With respect to Intelsat II, he said, NASA by affirmation and DOD at least by acquiescence had elected not to recover full costs.*

(U) Charyk also asserted that the legislative history of the Communication Satellite Act made it clear that Congress never intended ComSatCorp to pay a full-pro rata share of launch and support costs. However, the Air Force had earlier cited the same source in support of the opposite conclusion.

(U) Furthermore, he said, Intelsat's 58-nation consortium would most certainly protest against the unilateral imposition of retroactive charges. The President had recently affirmed U.S. commitments, the importance of U.S. leadership, and the desirability of continuing the consortium under definitive arrangements. Currently, however, certain Intelsat nations were resisting U.S. leadership. Dr. Charyk feared these nations might use the exaction of added charges to undermine that leadership. For this and lesser reasons, he believed that the charges would bring adverse and far-reaching effects. Consequently, he implored Secretary McNamara to reconsider the matter.+

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*Actually, as early as October 1965, representatives of the Air Force Office of General Counsel attempted to acquaint their counterparts in NASA of the Air Force intention to collect for all charges connected with support of the Intelsat II series and that at least one NASA official tried to sweep the matter under the carpet in view of its inherent complexity. [Memo (U), William W. Hancock, Dep Gen Counsel, to William Morrill, Bureau of Budget, 1 Dec 67, subj: DOD Launch Charges to ComSat.]

+A copy of Dr. Charyk's letter went to Eugene V. Rostow, Under Secretary of State for Political Affairs, who was also Chairman of the President's Task Force on Communication Policy.

(U) The Defense Chief subsequently directed ODDR&E to seek some sort of compromise. During the next four months, DOD agencies explored the issue further with NASA, consulted with Budget officials, and reexamined their own positions. Finally, on 3 February 1968, Dr. Foster proposed a solution to Willis H. Shapely, Associate Deputy Administrator, NASA.[9]

(U) Since the first three Intelsat II launches had preceded Secretary McNamara's letter of 24 April 1967, he suggested that NASA accept a billing for only direct charges for those launches. However, the fourth launch had followed Mr. McNamara's letter. Consequently, Dr. Foster proposed NASA pay the direct charges plus the incremental part of the indirect support charges and that this procedure be contained for future launches. Further discussion of the depreciation issue could await the new accounting system contemplated for the Eastern Test Range.

(U) On 20 May 1968, after discussing the matter with ComSatCorp officials, Mr. Shapely accepted Dr. Foster's proposal. Thus, the agreed billing to NASA for Air Force support of the first three Intelsat II launches totaled $434,290, about $1.9 million less than the Air Force thought due. Mr. Shapely also agreed to accept a figure of about $450,000 for the still unbilled fourth launch.[10]

(U) Long before the reimbursement question had been settled, ComSatCorp approached the Air Force about the possibility of using its Titan IIIB/Agena D combination to launch the 2,400-pound Intelsat IV satellites. The first launch would be no earlier than the fourth quarter of 1970; the series would be completed before the end of 1972. In November 1967 the Air Force furnished the corporation some preliminary data and on 26 March 1968 submitted specific cost information for several different launch and preparation combinations. Advised of the above, NASA asked the Air Force to study the Titan IIIB/Agena D at the Cape. Aside from its statutory responsibilities for commercial programs, the space agency also was interested in using the booster to support some of its future operations. On 29 April 1968 the Air Force certified that, under the parameters described for the Intelsat IV missions, the Titan IIIB/Agena D could orbit 2,542 pounds. It also noted, however, that a funded concept development study would be necessary before it could quote firm prices for developing the facility and booster/spacecraft combination.[11]

(U) Meanwhile, Dr. Flax suggested to DDR&E that before the Air Force commits itself to such a study or to support other Intelsat

programs, OSD should determine its own position. The major question was who would pay R&D costs for a new Titan IIIB/Agena D capability at Cape Kennedy. A case could be made for charging the ComSatCorp all or only a part of the costs. On the one hand, it could be argued that the corporation should pay for needed modifications to existing facilities at the Cape, since the government had no other firm requirement for this capability. On the other, since the value of the government installation would be increased--and there was always the possibility that the DOD might use them sometime--there were reasons for not charging ComSatCorp the full developmental cost.[12]

(U) Dr. Flax also proposed a review of NASA's role as intermediary between the Air Force and ComSatCorp. The Communication Satellite Act designated NASA as the government's contact with the corporation. Nevertheless, Dr. Flax felt that OSD should seek a more direct relationship between the Air Force and the firm. On 29 February 1968 he suggested to Dr. Foster that an OSAF/OSD ad hoc group first work out a DOD position. Then NASA and ComSatCorp could be approached for interagency discussion. Dr. Foster concurred in these suggestions and named an OSD team to work with Dr. Yarymovych, a member of Dr. Flax's staff. The group completed its work on 5 June 1968; at the end of the period Dr. Foster and Dr. Flax were reviewing its recommendations.[13]

(U) During fiscal year 1968 various considerations also led NASA and DOD to undertake another long-range review of national launch vehicle requirements.* The new study resulted from correspondence between Mr. Webb and Secretary McNamara in the fall of 1967. The space agency chief was aware that NASA could not expect the same liberal funding it had enjoyed during its first decade. The agency would have to retrench and, possibly, reorient its programs. Since any major shift in NASA emphasis would probably affect the military space effort, Mr. Webb decided to coordinate with Secretary McNamara before presenting recommendations to the President.[14]

(U) Among other moves that NASA must now consider, Webb wrote on 26 September 1967, was the possible use of Titan IIIM. Other questions related to the use of MOL equipment by NASA, in view of the early phaseout of Apollo equipment. A long term question was whether either agency would need a 100,000-pound payload and, if so, the most efficient way to boost it into orbit. Mr. Webb sent Secretary

*The last such study had been conducted by the Launch Vehicle Panel of the AACB during the latter part of 1964.

McNamara a copy of the guidelines under which the NASA staff was reassessing the agency's position. He also offered to cooperate in any effort the Secretary might suggest useful.

(U) Secretary McNamara replied on 10 October that the AACB might review appropriate booster configurations to fit NASA guidelines. The AACB took up the matter on 26 October. On 11 June 1968 the Launch Vehicle Panel reported to the Board that there was a potential requirement for additional unmanned launch vehicle capabilities for synchronous orbit and planetary/interplanetary missions. Three missions could not be accomplished short of using the Saturn V. These were space station logistic and manned missions in low-earth orbit (40,000-50,000 pounds), synchronous orbit missions (4,000-6,000 pounds), and planetary/interplanetary missions (requiring up to 50,000 feet/second total velocity). There was also a possible requirement for an intermediate launch vehicle (50,000-100,000 pounds to orbit), depending on future manned requirements not yet well defined.[15]

(U) The panel recommended it be authorized to undertake three studies. The first would determine the cost of performing NASA unmanned missions with existing Titan III configurations and a Titan III/Centaur combination. A second study would compare the costs of using the Titan IIIB and the Saturn IB for space station logistics and manned missions flying the 40,000-50,000-pound range in low-earth orbit. The third would determine the costs of various launch configurations accommodating the nebulous manned mission--50,000-100,000 pounds in low-earth orbit.

(U) On 11 June 1968 the AACB directed the panel to proceed with the recommended studies and to identify a family of vehicles that could best meet existing and planned needs of NASA and DOD. Also by this time, various agencies were conducting additional investigations which would help the panel in its work. These included internal NASA studies of Titan III capabilities and costs, as well as a national space booster study by Chrysler Corporation. Dr. Foster took steps to assure that the results of these additional investigations were made available to the Launch Vehicle Panel.[16]

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GLOSSARY OF TERMS AND ABBREVIATIONS

AACB	Aeronautics and Astronautics Board
ADC	Aerospace Defense Command
ADP	Advanced Development Plan
ADS	Advanced Data System
AFLC	Air Force Logistics Command
AFSC	Air Force Systems Command
ARSP	Aerospace Research Support Program
ASSET	Aerothermodynamic Elastic Structural Systems Environmental
ASSS	Air Staff Summary Sheet
AWS	Air Weather Service, Military Airlift Command
BM	ballistic missile
BMD	Ballistic Missile Defense
BMEWS	Ballistic Missile Early Warning System
B-N	Baker-Nunn (camera)
BOB	Bureau of the Budget
bud	budget
CAP	Coordinated Action Plan
CF	Case File
ch	chief
chmn	chairman
CINCLANT	Commander in Chief, Atlantic
CINCNORD	Commander in Chief, North American Air Defense Command
cmte	committee
comd	command
comdr	commander
comdt	commandant
COMSAT	communication satellite
ComSatCorp	Communications Satellite Corporation
con	control
CONAD	Continental Air Defense Command
cpbl	capability(ies)
CSAF	Chief of Staff, United States Air Force
DCA	Defense Communications Agency
DCP	Development Concept Paper
DCS	Deputy Chief of Staff
DD	development directive (followed by a number)

DDR&E	Director of Defense Research and Engineering
def	defense
dep	deputy
det	detachment
dev	development
D&F	determination and findings
DIA	Defense Intelligence Agency
dir	director, directorate
DOD	Department of Defense
DODGE	DOD Gravity Gradient Experimental (program)
DSCS	Defense Satellite Communication System
dspn	disposition
ECI	Electronics Communications Inc
ECM	electronic countermeasure
ESD	Electronic Systems Division (of AFSC)
estb	establish(ment)
ETR	Eastern Test Range
EXCELS	Expanded Communications Electronics System (SCF)
FAA	Federal Aviation Administration
fin	financial
FOBS	fractional orbit bombardment system
FRC	Flight Research Center (NASA)
FTV	Flight Test Vehicle
gdnce	guidance
gnd	ground
gp	group
HASP	High Altitude Surveillance Platform
HR	House of Representatives
ICBM	intercontinental ballistic missile
impl	implementation
Intelsat	International Telecommunications Satellite Consortium
intvw	interview
IOC	Initial Operating Capability

JCS	Joint Chiefs of Staff
LASP	Low Altitude Surveillance Platform
LES	Lincoln Laboratories Experimental Satellite
LO_2LH_2	liquid oxygen/liquid hydrogen
LWIR	long wave infrared
MCEB	Military Communications-Electronics Board
MCP	military construction program
mgt	management
MOL	manned orbiting laboratory
MR	memorandum for record
MRS	Maneuverable Reentry System
M/U	Memorandum of Understanding
NASA	National Aeronautics and Space Administration
NATO	North Atlantic Treaty Organization
nav	navigation
NM	nautical mile
NORAD	North American Air Defense Command
NSEG	Navigation Satellite Executive Steering Group
nuc	nuclear
OAR	Office of Aerospace Research
OCAMA	Oklahoma City Air Materiel Area
ODDR&E	Office of the Director of Defense Research and Engineering
ofc	office
op	operation(s)
opl	operational
OSAF	Office of the Secretary of the Air Force
OSD	Office of the Secretary of Defense
OTH	over the horizon (radar)
PAR	phase array radar (Air Force); perimeter acquisition radar (Army)
PCD	program change decision
PCR	program change request
PE	program element
PEM	program element monitor

PILOT	Piloted Low Speed Tests
plcy	policy
PRIME	precision recovery including maneuvering reentry
procd	procedure(s)
prog	program(s)
proj	project
PTDP	Preliminary Technical Development Plan
R&D	Research and Development
RDT&E	Research, Development, Testing, and Engineering
reimb	reimbursement
rg	range
rkt	rocket
ROC	required operational capability
rprt	report
rqmt	requirement(s)
SA	Secretary of the Army
SABAR	Satellites, Balloons, and Rockets
SAC	Strategic Air Command
SAF	Secretary of the Air Force
SAMSO	Space and Missile Systems Organization
sat	satellite
SCF	satellite control facility
SEA	Southeast Asia (Vietnam, Thailand, Laos, and Cambodia)
SECDEF	Secretary of Defense
SESP	Space Experiments Support Program
SGLS	Space Ground Link Subsystem
SHAPE	Supreme Headquarters Allied Powers Europe
SHF	super high frequency
SLBM	sea-launched ballistic missile
SLV	standard launch vehicle
SOS-70	Surveillance of Objects in Space in 1970's, an AFSC study
SOSTI	Space Object Surveillance, Tracking, and Identification
SPARS	Space Precision Attitude Reference System
SPO	System Project Office
spt	support
START	Spacecraft Technology and Advanced Reentry Tests
stmt	statement
stn	station
strat	strategic

STRAT-70	Strategic Operations in the 1970's, an Air Force study
sup	supplement; supply
survl	surveillance
sys	system(s)
TDP	technical development plan
tech	technical
term	termination
trml	terminal(s)
TSCP	Tactical Satellite Communication Plan
TSEG	Tactical Satellite Executive Steering Group
UHF	ultra high frequency
U/SAF	Under Secretary of the Air Force
VAFB	Vandenberg Air Force Base
VCS	Vice Chief of Staff, Air Force
veh	vehicle
WWABNCP	Worldwide Airborne Command Post

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